# ASSESSMENT OF HUMOS USING VOLUNTEER TESTS

**B. Deng**[a], **J.T. Wang**[a] and **P. Slaats**[b]

[a]General Motors Research & Development Center
Warren, Michigan 48090-9055
bing.deng@gm.com

[b]TNO-MADYMO North Amarica
Livonia, Michigan 48152
slaats@madymo.com

The validity of the full human body model in MADYMO, called HUMOS (HUman MOdel for Safety) [1], was assessed using volunteers subject to either frontal or rear impact conditions. The volunteers were fairly representative in height and mass of the North American 50th percentile adult male. The head and thorax kinematics of the HUMOS in the mid-sagittal plane were obtained and compared to volunteer responses.

HUMOS has a total of 63,036 nodes and 63,978 elements (51,601 2D elements and 12,377 3D elements) with a minimum time step of 0.001 ms. Its geometry represents a mid-size German male with a height of 1.75 m and a mass of 75.5 kg. The model consists of 88 rigid bodies and 45 finite element parts. Rigid body joints are used to accommodate the articulations between the various skeletal structures.

The frontal impact test was conducted using a horizontal HYGE-type accelerator at Wright-Patterson Air Force Base (WPAFB) at 9.8 g acceleration level. A double shoulder strap harness, a lap belt harness, and a crotch strap, restrained the subject. Pre-simulations were run to fit the belt system on the HUMOS. Linear and angular accelerations were recorded at the mouth and the chest. Displacements of the cheek, the mouth, the shoulder, and the knee were measured. Belt loads were collected at each shoulder belt, the lap belt harness, and the crotch strap. Simulation results were compared to the experimental measurements.

Nine low speed rear impact sled tests with unbelted volunteers conducted at Japan Automobile Research Institute (JARI) were used [2]. A relatively soft pulse with peak acceleration about 3.8 g was imposed for the simulation. Displacements and accelerations were recorded at the head center of gravity (HDCG), the occipital condyles (HDOC), and the first thoracic spine (T1). Simulation results were compared to the response corridors from the experimental measurements.

Volunteer tests, including frontal impact and rear end impact, were simulated successfully using HUMOS. The successfulness of correlating the simulated occupant kinematics with volunteer test results has been limited so far due to the development status of the HUMOS. Improvements are needed in the model to obtain more accurate kinematics. We have not been able to explore HUMOS's capability on injury prediction, since the volunteer tests produced no tissue failure. We see the need to conduct extensive research in advanced biomaterial models, as well as injury mechanisms and biomechanics-based injury criteria.

**References**

[1] MADYMO Version 6.0, TNO Automotive.
[2] Riske Meijer, Koshiro Ono, Jack Van Hoof, and Koji Kaneoka, "Analysis of Rear End Impact Response Using Mathematical Human Modeling and Volunteer Tests", JSAE Spring Conference Yokohama, JSAE 20015357, 2001.